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THE EFFECTS OF GLP-1 USE ON MENTAL HEALTH, SELF-RATED HEALTH, EMPLOYMENT AND MARRIAGE

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ABSTRACT

In this article, we exploit the recent, rapid diffusion of the use of GLP-1 drugs among individuals with diabetes to measure the effect of the use of these drugs on mental health, self-rated health, employment, and marriage. The documented large weight loss from GLP-1 use may plausibly affect these outcomes and evidence of these broader impacts of GLP-1 use is necessary to evaluate their full value. Estimates are obtained using a longitudinal (within-person) regression approach. Results indicate that GLP-1 use is not meaningfully associated with mental health, self-rated health, employment, and marriage. Overall, our analysis adds new evidence about how GLP-1 use is affecting the lives of individuals with diabetes.

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Introduction

The use of long-acting Glucagon-like peptide-1 receptor agonists (GLP-1s) to treat diabetes has expanded rapidly after the introduction of Ozempic in 2018 and similar products after that. Table 1 shows that among a sample of people with diabetes drawn from the Medical Expenditure Panel Survey (MEPS), use of long-acting GLP-1s increased from low single digits prior to 2018 to 23% among males and 31% among females by 2023. The growth in GLP-1 use is driven by evidence showing that GLP-1s are as, or more, effective for glycemic control than other prominent pharmaceuticals such as metformin (Guillermo et al. 2014; Sørensen et al. 2024). GLP-1s also have beneficial effects on weight loss and adverse cardiovascular events (Rivera et al. 2024). It is the weight loss properties of GLP-1s that make them the recommended first line pharmaceutical treatment for people with diabetes who are overweight or obese (American Diabetes Association Professional Practice Committee for Diabetes 2026; Samson et al. 2023). And because 88% of people with diabetes are overweight or obese, it is easy to see why the use of GLP-1s to treat type 2 diabetes is growing and is likely to continue to grow.

The positive effects of GLP-1 use on weight loss are well documented. In a recent meta-analysis of 47 randomized control trials, Wong et al. (2025) reported that GLP-1 use was associated with a mean reduction in weight of 4.6 kilograms. Two Cochrane Systematic Reviews (Franco et al. 2026; Bracchiglione et al. 2026) and other studies (Jastebroff et al. 2022; Jastebroff et al. 2025) concluded that GLP-1 use (semaglutide and tirzepatide) had substantially larger effects (e.g., 20 to 50 pounds). While the effects of GLP-1 use on glycemic control, weight loss and cardiovascular disease have been an area of extensive study, there is relatively little evidence of other potential consequences of GLP-1 use, particularly those related to weight loss. In this article, we address this gap by studying the association between GLP-1 use and mental health, self-rated health, employment and marital status among adults with diabetes. Each of these are important aspects of wellbeing and plausibly influenced by the weight loss associated with GLP-1 use. Indeed, in a recent survey of 2000 GLP-1 users by Morning Consult and reported in the New York Times, approximately 50% of users indicated that GLP-1 use had affected their relationships with friends and family and their social life, and 60% said GLP-1 use had affected their productivity.[1] These figures highlight the plausibility of the research questions we investigate and the wider potential impacts of GLP-1 use.

It is well documented that obesity and mental health disorders are often comorbid, although the causal direction of the relationship is uncertain (Simon et al. 2006; De Wit et al. 2010; Luppino et al. 2010; Avila et al. 2015; Jantaratonai et al. 2017). That said, there is evidence that weight loss is associated with improved mental health (Foster et al. 1997; Miller and Downey 1999; Blaine et al. 2007; Lasikiewicz et al. 2014; Jones et al. 2012). For example, Blaine et al. (2007) reviewed results from 77 studies of weight loss interventions and concluded that modest weight loss (7% of body weight) was associated with significant improvements in self-esteem and depressive symptoms. These results suggest that GLP-1s may also have beneficial effects on mental health, and it is this evidence that motivates our analysis of the effect of GLP-1 use on mental health.

Our study of the effects of GLP-1 use on mental health will add significantly to a limited evidence base. O'Neil et al. (2017) examined data from several randomized control trials (SCALE) of Liraglutide (a GLP-1) and found no difference in adverse neuropsychiatric events or depression. Similar results were reported by Wadden et al. (2024) with respect to the STEP randomized control trials and adverse events. This evidence is also summarized in Silverii et al. (2024) who examined evidence of adverse events from 31 randomized control trials and found no difference. De Giorgio et al. (2025) also

[1] Julia Belluz, "The Great Ozempic Experiment", New York Times April 15, 2026; https://www.nytimes.com/interactive/2026/04/15/opinion/glp1-health-effects.html

reported that for 10 RCTs, GLP-1s were not associated with mood or anxiety disorders. In contrast to the results from RCTs, Moulton et al. (2016) reported that GLP-1 use was associated with an improvement in depressive symptoms in the South London Diabetes Study, which was an observational study. Similarly, Tsai et al. (2022) reported that GLP-1 use was associated with a decrease in anxiety and depressive symptoms in an observational study based on Taiwanese medical claims, which are also limited measures of mental health. De Giorgio et al. (2025) provide a summary of results from observational studies reporting that nine out of 16 reported a beneficial effect of GLP-1 use on mood and anxiety.[2]

As just described, the effects of GLP-1 use on mental health are not uniform, often come from studies based on adverse drug events, which are limited measures of mental health, and much of it comes from randomized trials that lack a real-world setting and broad, population-based samples. In this study, we use a national sample of adults with diabetes drawn from the Medical Expenditure and Panel Survey (MEPS) to study the effect of GLP-1 use on the Kessler-6 measure of psychological distress and the PHQ3 measure of depressive symptoms.

Another potential consequence of the weight loss associated with GLP-1 use is employment. There is widespread evidence of bias against and stigmatization of overweight and obese people across many domains such as healthcare provision and the labor market (Puhl et al. 2010; Phelan et al. 2015; Rubino et al. 2020). Given this evidence, it is not surprising then that there is a substantial literature that examined the association between weight status and labor market outcomes. Much of this research is observational (Cawley 2004; Tunceli et al. 2006; Morris 2007; Greve 2008; Lindeboom et al. 2010). Though research has examined the association between weight status and labor market outcomes, there is no existing research that we are aware of that examined the direct effect of GLP-1 use on employment. We address this question for a population of people with diabetes, who have relatively low employment rates and for whom weight loss and other health improvements may have important labor market benefits.

The weight loss associated with GLP-1 use may also affect marriage. There has long been interest in the association between weight status and relationship status (Jeffrey and Rick 2002; Lee et al. 2005; Averett et al. 2008; Dinour et al. 2012). Economic models of the marriage market (e.g., Ciappori et al. 2012; Grossbard 2012; Mata et al. 2018) suggest that weight status and other physical attributes influence marriage and relationship status. Moreover, people make investments in characteristics that influence a match, for example, by maintaining a certain weight. A commonly used phrase, “happy weight”, which refers to changes in weight during marriage has been the subject of academic research and highlights the argument linking GLP-1 use to marriage (Sobal et al. 2009; Clark and Etile 2011; Dinour et al. 2012; Kazuma 2021; Sato 2021; Huntington et al. 2022). It is through this relationship matching process that weight loss associated with GLP-1 use may affect marriage and relationship status.[3] Interestingly, recent newspaper articles report on the disruptive effects of GLP-1 use on relationships.[4] Here too, we know of no prior research that has investigated this research question.

Finally, we examine the association between use of GLP-1 use and self-rated health. Surprisingly, this is also an area that is relatively under studied. We could find only one (unpublished) relevant article

[2] Similar reviews and conclusions are found in Tempia et al. (2024) and Pierret et al. (2025).

[3] A similar causal pathway has motivated studies of the effect of bariatric surgery on relationship status (Clark et al. 2014; Bruze et al. 2018). Results from these studies are mixed. Bruze et al. (2018) reported that bariatric surgery is associated with more divorce where as Clark et al (2014) reported that weight loss was associated with improved partnership relations.

[4] See, for example: “How Weight-Loss Drugs Can Upend a Marriage,” Lisa Miller, New York Times February 2, 2025; “Weight Loss Drugs Ended Their Sex Life. Could it Bounce Back?”, Lisa Miller, New York Times December 24, 2025; and “Is Weight Loss Medication a Catalyst for Divorce?” Azadeh Aalai, Psychology Today February 12, 2025.

(Admassu 2025). Clearly, and as prior evidence has documented, GLP-1 use leads to weight loss, improved glycemic control and reduced likelihood of adverse cardiac events that would seemingly result in better self-rated health. However, Admassu (2025) reported that GLP-1 use was associated with worse self-rated health. Given the lack of research on this issue and the wide use of self-rated health as a valid measure, our research will contribute to evidence on the effects of GLP-1 use on summary measures of general health.

To summarize, in this article, we exploit the recent expansion of the use of GLP-1 drugs among individuals with diabetes to measure the effect of the use of these drugs on mental health, self-rated health, employment, and marriage.[5] These outcomes are important dimensions of wellbeing, plausibly linked to the demonstrated weight loss of GLP-1 drugs, and understudied. To accomplish this objective, we use data from the MEPS from 2012 to 2023, which is a period spanning the growth of GLP-1 use, and focus on a sample of people diagnosed with diabetes who, during this period, have the highest rate of GLP-1 use, as GLP-1 use among the general population was still very low in 2023.[6] Estimates of the association between GLP-1 use and outcomes are obtained from cross-sectional and longitudinal (first difference and value-added) regression models. Our preferred approach is the longitudinal analysis because this approach controls for unmeasured, person-specific variables that may confound associations between GLP-1 use and outcomes and because these models are consistent with the human capital model of health production in which GLP-1 use is an investment in health.

Results of the analysis indicate that GLP-1 use is not meaningfully associated with mental health, self-rated health, employment, and marriage. Our findings with respect to mental health are consistent with evidence from most randomized control trials that examined different indicators of mental health than those used in this analysis but differ from those from observational studies from the UK and Taiwan. Our analyses of the effects of GLP-1 use on employment and marriage are novel, so we have no prior results to compare ours to. We do not find an effect of GLP-1 use on marriage in contrast to some anecdotal reports in newspapers. Overall, our analysis adds new evidence about how GLP-1 use is affecting the lives of individuals with diabetes and suggest that the value of these drugs lies mostly in the primary outcomes of glycemic control and weight loss.

Empirical Approach

To obtain estimates of the effect of GLP-1 use on mental health, self-reported health, employment and marriage, we first estimate a cross-sectional model in which the aforementioned outcomes are regressed on GLP-1 use, which is measured as proportion of time in the last two years up to the second-year outcome measurement (inclusive of the round) that a person had a GLP-1 prescription. The reason for measuring GLP-1 use this way is that it takes time, for example, six months to a year, for GLP-1 use to result in significant weight loss. The regression model specification is described by the following:

[5] Ideally, we would estimate the association between use and GLP-1 and weight loss, as this is the primary mechanism linking GLP-1 use to the outcomes we examine. Unfortunately, the MEPS has information on weight in only three of the seven years between 2017 and 2023 when GLP-1 use was expanding. The missing information severely reduces the sample size, particularly in the longitudinal (e.g., first-difference) models that are the preferred approach.

[6] The rate of use among non-diabetics is very low, but the number of users is large relative to the number of users who are diabetics, which reflects the relatively low rate of diabetes in the population (https://www.kff.org/health-costs/kff-health-tracking-poll-may-2024-the-publics-use-and-views-of-glp-1-drugs/).

$$(1)\ Y_{it} = \sum_{t=2013}^{2023} \delta_t YEAR_{it} + \sum_{r=2}^{4} \sigma_r REGION_{ir} + \sum_{m=26}^{64} \gamma_m AGE_{im} + \sum_{k=2}^{4} \lambda_k RACE\_ETH_{ik} +$$

$$\sum_{l=2}^{4} \rho_l EDUC_{il(t-1)} + \sum_{g=2}^{3} \pi_g ILLNESS_{ig(t-1)} + \beta PROP\_GLP1_{it} + e_{it}$$

In equation (1), the dependent variable (Y_{it}) is one of the previously described outcomes such as mental health or self-rated health. The model includes dummy variable indicators for each: year (*YEAR*), region (*REGION*), age (*AGE*), race/ethnicity (*RACE_ETH*), education (*EDUC*), and illness (ILLNESS: diabetes, hypertension, hyperlipidemia, cancer, heart condition). Not shown, but included in the regression, is an indicator for being born in US; indicator for having health insurance; person survey weights and its square; and survey weights related to completing the self-administered survey and its square.[7] Year, region, and age are measured in the same year of the outcome to account for current year, region, and age effects on the outcomes. All other covariates (e.g., race, education, and illness) are measured at the baseline, for example, in 2014 for outcomes measured in 2015. Specifically, we measure the presence of several comorbidities at baseline (e.g., heart conditions, hypertension, high cholesterol, and cancer) because these may change over time and could be influenced by subsequent GLP-1 use. We control for these baseline characteristics as they are potentially correlated with both the outcomes and GLP-1 use.

Estimates from equation (1) provide partial (conditional) correlations between GLP-1 use and outcomes and is a useful, descriptive starting point. However, if health is viewed as a stock determined by investments in health and depreciation, as in the human capital model of health, then a longitudinal model can be used. In the human capital model (e.g., Grossman 1972) the change (difference) in health between two ages depends only on the investments in health during that period and the rate of depreciation in that period. The lifetime history of investments and depreciation, which should be included in a properly specified cross-sectional model (i.e., equation 1) are no longer relevant because the impact of those past investments is eliminated by taking the difference. For example, the change in mental health of a person between ages 50 and 51 will depend on investments in health in the year prior to age 51 and the amount of depreciation of health that occurs during this period. The regression model consistent with this conceptualization is:

$$(2)\ Y_{it} = \phi_t Y_{i(t-1)} + \sum_{t=2013}^{2023} \delta_t YEAR_{it} + \sum_{r=2}^{4} \sigma_r REGION_{ir} + \sum_{m=26}^{64} \gamma_m AGE_{im} + \sum_{k=2}^{4} \lambda_k RACE\_ETH_{ik} +$$

$$\sum_{l=2}^{4} \rho_l EDUC_{il(t-1)} + \sum_{g=2}^{3} \pi_g ILLNESS_{ig(t-1)} + \beta PROP\_GLP1_{it} + e_{it}$$

The main point to note about equation (2) is the inclusion of the lagged outcome in the model. The coefficient on that lagged outcome is a measure of depreciation (actually one minus depreciation). As written, equation (2) is sometimes referred to as a value-added model (Todd and Wolpin 2003). If depreciation is zero, then the model can be estimated as a first-difference specification. One feature of equation (2) to note is that covariates are not measured in differences. The reason for this is that the dependent variable is a stock of health and changes in that stock of health come from the amount (level) of investments in health during the period and not the change investments (Faundez and Kaestner 2025; Kaestner et al. 2025). To see why, consider a person who invests the same amount in health each year. The health stock of this person will, all else equal (e.g., depreciation), grow over time (as they age) despite the fact that the difference in investment is zero. What matters is the amount of investment in the previous period and not whether the amount of investment changes. This is widely misunderstood issue.

[7] Including the survey weights is motivated by an argument like that used to justify the inclusion of the propensity score in a regression model (Korn and Graubard 1995). Sampling variability related to the survey design may alter the observed and unobserved characteristics of the sample. Conditioning on the observed characteristics (e.g., age, region, etc.) used to select the sample is a partial solution, but there may be unmeasured factors that change with the sample that are correlated with the outcome and covariates. Inclusion of survey weights is another approach to addressing the sampling variation and its impact.

The same amount of investment may be made each period and the difference in the level of investment would be zero, but the health stocks would still grow because there was positive investment in the last period.[8] For example, GLP-1 use is measured as the proportion of time between outcome measurements in period one and two that a GLP-1 was used and is a direct measure of one investment that partly determines the change in the health stock. Variables such as education and race/ethnicity are also likely to be correlated with the amount or productivity of investments in health during the period and therefore belong in the model (i.e., not differenced out even though they are time invariant). It is also important to include the current age in the model as the rate of depreciation will differ by age and including age adjusts for this difference. All covariates are as described before in equation (1).

While equation (2) eliminates the confounding from unmeasured past investments and from the health endowment (time-invariant component) due to the inclusion of the baseline health outcome, there still may be unmeasured contemporaneous investments (and depreciation) that would lead to an omitted variable bias of the causal effect of GLP-1 use on outcomes. For example, a contemporaneous health shock may cause a person to take GLP-1s and influence their health. Including baseline controls for illness indicators helps address this concern because this specification allows for time-varying effects of the baseline conditions, although not a time-varying change in condition. For example, a person with a heart condition at baseline may be more likely to experience greater depreciation (i.e., a health shock) and that would affect health at time two. Given that baseline health is highly correlated with the health shock, then the specification addresses this possible source of bias. Similarly, including other baseline controls such as education that are likely highly correlated with investment and depreciation control for similar potential biases.

We acknowledge that, ultimately, we do not have an empirical approach that identifies a causal effect of GLP-1 use with certainty, or a high degree of probability that would be sufficient to claim we have identified a causal interpretation. That said, we believe that the expansion of GLP-1 use among those with diabetes is mainly driven by the general diffusion of GLP-1s, for example, that varies because of provider proscribing patterns, peer group use, and characteristics that we measure and include in the regression model. It is not implausible that unmeasured characteristics that determine the use of GLP-1 drugs are largely exogenous such as needle phobia and the likelihood and incidence of adverse side effects. If so, then estimates from equation (2) may be relatively close to the true causal estimates and we think they are informative, particularly because of the lack of prior research on the research questions we address.

Besides mental and self-rated health, we also examine employment and marriage. The human capital model of health that was used to motivate the specification of equation (2) is also plausibly applicable to these non-health outcomes. Consider marriage. It is an outcome that is determined by purposeful actions, which are analogous to investments, that influence whether a person gets or remains married. The timing of investments and the outcome are also similar. Investment precedes the outcome and changes in the outcome are a result of investment during the period. While perhaps not the typical

[8] There is some nuance to what we mean by a period and the change between periods. Theoretically, the sequence (timing) is clear: investment during period one (and depreciation) and then health at the start of period two. The difference in health at the start of period two and the start of period one depends on the level of investment and depreciation throughout period one. In practice, health is measured at a given point during the year, for example, June of the year the person is age 51. So, the difference in health is the difference between health in June of the year the person was age 51 and June of the year the person was age 50. GLP-1 use is measured as the proportion of time between June at age 50 and June at age 49. Note that in equation (1), which is the cross-sectional model, GLP-1 use is the proportion of time in the last two years prior to the second-year outcome measurement that a person had a GLP-1.

scientific evidence, a "google" search of the phrase "investing in your marriage" turns up hundreds of webpages and supports our argument.

In the case of the relationship between GLP-1 use and employment, we see the causal mechanism as stigma, both internalized and external, and discrimination toward overweight and obese people. The key measure is weight status. Given this, it is the change in weight status that is the appropriate measure to use in equation (2) when employment is the outcome. For example, an overweight or obese person may have difficulty finding and keeping a job because of the stigma and discrimination associated with weight status. Thus, the change in the probability of being employed depends on the change in weight status. GLP-1 use is a very good proxy for the change in weight status because of the weight loss properties of GLP-1. Therefore, the proportion of time using a GLP-1 is the appropriate measure to use in the employment regression.

The final point we note about the empirical approach is that we conduct all analyses stratified by sex. This choice is motivated by differences in the means of dependent variables and GLP-1 use. Another reason to stratify by sex is evolving evidence that GLP-1s may have different effects by sex (Stina and Skibicka 2025; Yang et al. 2025).

Data

We used data from the 2012 to 2023 Medical Expenditure Panel Survey (MEPS) from IPUMS (Blewett et al. 2025). MEPS is a large, national survey of individuals on a wide range of topics including the use of healthcare services such as prescription drugs, physical and mental health status, medical conditions, as well as a rich set of demographic and socioeconomics characteristics. We used years from 2012 to 2023 to allow for a sufficient pre-period (2012 to 2017) and post-period (2018-2023) around the expanded use of GLP-1 for the treatment of diabetes from 2018 (see Table 1).

Our sample included individuals aged 25 to 64 years old who report ever being diagnosed with diabetes and were observed for at least two years. From 2012 to 2019 and 2023, individuals were interviewed for five rounds in a two-year period. For years 2020 to 2022, due to the COVID-19 pandemic, individuals were interviewed for up to nine rounds in a four-year period. For each individual, we create one observation for each adjacent two-year period, for example, year 1 (baseline) and year 2, year 2 (baseline) and year 3, and year 3 (baseline) and year 4. The analysis sample includes 4,284 observations for the female sample and 3,672 for the male sample.

We chose study outcomes that are plausibly affected by the use of GLP-1 including mental health, employment, and marital status.[9] All outcomes are measured in the second round of interview in a year, for example, in round 2 in year 1 (baseline) and round 4 in year 2. Measures of mental health include the well-validated Kessler 6 Scale (K6) that measures non-specific psychological distress and the Patient Health Questionnaire (PHQ-2) that screens for depression. The K6 score ranges from 0 to 24 based on how often an individual felt during the past 30 days: so sad that nothing could cheer you up; nervous; restless or fidgety; hopeless; that everything was an effort; and worthless. The PHQ-2 score ranges from 0 to 6 based on an individual's response to two questions on "during the past two weeks, bothered by having little interest or pleasure in doing things, and bothered by feeling down, depressed, or hopeless." For K6, we examined the effect of GLP-1 use on the K6 summary score and a dichotomous indicator that the K6 score was greater than 5, which can indicate moderate to severe psychological distress (Prochaska et al. 2012). For PHQ-2, we created an indicator variable for PHQ-2 score being 3 or greater, which

[9] Alcohol use has also been linked to GLP-1 use. However, MEPS did not obtain information about alcohol use from 2012 to 2017.

indicates plausible depression (Levis et al. 2020). Additionally, employment is measured by an indicator for being employed during the round. For marital status, we defined an indicator for whether an individual is married and an indicator for whether an individual is divorced, separated, or widowed.

The prescription drug event files of MEPS include all prescription drugs filled by individuals during a year. The information on prescription drug use is collected via a two-stage process: initial data (e.g., drug names and fill counts) is gathered from survey respondents at each round of interview, followed by detailed, verified information (e.g., national drug code, date, and payment sources) collected directly from pharmacies with user permission. Use of GLP-1 is identified using the Multum Lexicon therapeutic classes, specifically, GLP-1 drugs are classified under the therapeutic classes of metabolic agents, then antidiabetic agents, then incretin memetics. We also cross-checked all GLP-1s by using both the generic and brand drug names that are also available in the event files and with reports elsewhere (e.g., Hegland et al. 2024). All GLP-1s include exenatide, liraglutide, dulaglutide, semaglutide, and tirzepatide, while long-acting GLPs include liraglutide, dulaglutide, semaglutide, and tirzepatide, and extended-release exenatide (Bydureon, Bydureon BCise, or Bydureon PEN).[10] We focus on long-acting GLP-1s because they have greater metabolic and weight loss effect, thus greater potential effect on the outcomes we examine (Yuan et al. 2023). Note that in the sample period, the vast majority of GLP-1s are long-acting.

For each individual, we measure their use of GLP-1 in two ways that are consistent with the conceptual model in equations (1) and (2). For the cross-section model, we measure GLP-1 use as the proportion of time in the last two years up to the second-year outcome measurement (inclusive of the round) that a person had a GLP-1 prescription. For the first-difference and value-added models, we measure GLP-1 use as the proportion of time between outcome measurements in period one and two that a GLP-1 was used. In sensitivity analysis, we use the cross-section measure in the first-difference and value-added models and the results are similar. We also created an indicator variable for any use of long-acting GLP-1s.

Additionally, MEPS includes demographic and socioeconomic variables that we used as covariates in the regression models. These included age (individual year), sex, race and ethnicity (White, Black, Hispanic, and Other), census region of residence (Northeast, Midwest, South, and West), education (less than high school, high school, some college, and college or more), whether an individual was born in the U.S, and whether individual had health insurance. Note that the estimates are almost identical to the inclusion of health insurance status. We also controlled for the presence of several illnesses at baseline that were common comorbidities with diabetes including heart conditions, hypertension, high cholesterol, and cancer as they may be correlated with both GLP-1 use and health status. We also included the final person weight and final self-administered questionnaire weight and their squared terms in the regression to account for survey design and sampling in cross-sectional analyses like ours.

Table 1 presents the use of long acting GLP-1 among individuals with diabetes by year and sex (female in the left panel and male in the right panel). The first measure, GLP-1 in Year, shows the share of sample using any GLP-1 increased substantially after 2017 following the introduction of Ozempic. The second and third measure captures the treatment consistent with the conceptual models: proportion of time in the last two years up to the second-year outcome measurement that a person had a GLP-1 prescription (for the cross-section model) and proportion of time between outcome measurements in

[10] Lixisenatide (a GLP-1 used once daily) was approved in the U.S. in 2016, but there was no prescription events associated with it in MEPS. In 2016 MEPS, there are 128 cases of GLP-1 receptor agonists with unspecified brand drug name or generic ingredient names and they are counted in all GLP-1, but not in long-acting GLP-1.

period one and two that a GLP-1 was used (for the first-difference and value-added model). Both measures increased substantially following 2018 for both female and male.

Table 2 provides descriptive statistics for the sample in years prior to 2018, before the introduction of Ozempic. For both females and males, the average age among individuals with diabetes is approximately 52 years. Approximately 30% of women with diabetes are Black, compared to 23% of men. The two groups are similar in terms of educational attainment — for example, approximately 66% of both females and males have a high school degree or less. The groups are also comparable in their limited use of GLP-1 medications prior to 2018. Turning to outcomes, the female sample reports higher K6 and PHQ-2 scores than the male sample, indicating poorer mental health. The female sample also reports poorer self-rated health more broadly: approximately 17% of women report good to excellent health, compared to 21% of men. Regarding employment, 47% of the female sample are employed, compared to 66% of the male sample. Finally, 47% of women are married, compared to 64% of men. This gap likely reflects the tendency for women to marry older men, combined with men's higher mortality rates at each age, which together result in a greater likelihood of widowhood among women (Choi and Vasunilashorn 2014).

Cross-sectional Regression Estimates

Table 3 reports OLS estimates of associations between GLP-1 use and measures of mental health, self-rated health, employment and marriage. These estimates are from the cross-sectional model. Among females, estimates indicate that GLP-1 use is not associated with mental health, as estimates pertaining to the three measures are small and not statistically significant. GLP-1 use is associated with a sizeable (30%), although not statistically significant decrease in the probability of being in excellent health. With respect to employment, GLP-1 use is associated with a 4.6 percentage-point (10% of the mean) increase in the probability of working, although the estimate is not statistically significant. GLP-1 use is also associated with a 6.7 percentage-point (14%) increase in the probability of being married and a six percentage-point (18%) decrease in the probability of being divorced, separated or widowed.

Except for one, estimates in Table 3 for the male sample are not statistically significant, but several are moderately sized. GLP-1 use is associated with: a 16% increase in the probability of psychological distress (K6>5) and a 30% increase in the probability of major depressive symptoms (PHQ-2); a 30% decrease in the probability of being in excellent health and a 17% increase in the probability of being in poor health; and a 23% increase in the probability of being married.

Overall, estimates in Table 3 suggest that GLP-1 use has substantial impacts on outcomes. For both males and females, GLP-1 use is associated with worse physical health and worse mental health for males. And for both sexes, GLP-1 use is associated with an increase in the probability of being married, and an increase in the probability of being employed for females. The lack of statistical significance of estimates of moderate magnitude reflects the power of the analysis, Generally, the study is under powered to detect reliably effect sizes less than 20% of the mean. Given the documented magnitude of weight loss (e.g., 20 to 30 pounds) associated with GLP-1 use, moderate effects sizes are plausible, and the study is sufficiently powered to detect such effects.

Longitudinal Regression Estimates

We now turn to the longitudinal estimates, which are reported in Table 4. Two sets of estimates are shown for each outcome: one set of estimates is from a first-difference specification that assumes that depreciation is zero, and a second set is from the value-added specification that includes the lagged value of the outcome on the right-hand side. The first point of note about estimates in Table 4 is that none are

statistically significant. Second, all but two of the estimates are small in magnitude and less than 10% of the mean. For example, whereas cross-sectional estimates indicated that GLP-1 use was associated with a 7- to 14-percentage point increase in marriage, analogous longitudinal estimates are virtually zero. The two moderately sized effects pertain to the estimates of associations between GLP-1 use and the probability of being in excellent health, but these estimates are somewhat imprecise and variable across specifications suggesting no true effect. Third, and as noted with respect to marriage, estimates in Table 4 are almost always substantially smaller than the cross-sectional estimates in Table 3. Finally, while estimates are not identical across the first-difference and value-added specifications, the specification does change the implications of the estimates.

In sensitivity analysis (Appendix Table 1), we re-estimated first-difference and value-added models that used an alternative measure of GLP-1 use: the proportion of time in the last two years that a person had a GLP-1 prescription. This was the measure used in the cross-sectional analysis. If the effects of GLP-1 cumulate, this specification may reveal this. Our discussion of these results is brief because estimates in Appendix T1ble 1 are very similar to those in Table 4. GLP-1 use is not meaningfully associated with health, employment or marriage.

Discussion

In this article, we provided important new evidence on the broader social and health impacts of the expanded use of GLP-1 receptor agonists among adults with diabetes that goes beyond the well documented effects of GLP-1 use on glycemic control, weight loss, and major adverse cardiovascular events. To do so, we leveraged the rapid diffusion of GLP-1 use among individuals with diabetes to obtain estimates of the effect of GLP-1 use on mental health, self-rated health, employment and marriage.

Results from the analysis suggest that the rapid diffusion of GLP-1 use has not had a materially significant effect on mental health, self-rated health, employment, and marriage. Preferred estimates of associations between GLP-1 use and the outcomes are generally small (less than 10% of the mean) and not statistically significant. Results with respect to mental health align with those from most randomized control trials that examine different indicators of mental health than those used in this analysis and different (non-representative) samples. Our results differ from observational studies from the UK and Taiwan that found GLP-1 use was associated with improved mental health. A novel contribution of our study was to investigate the impact of GLP-1 use on employment and marriage, as the substantial weight loss associated with GLP-1 use plausibly affects these outcomes. We do not find significant associations between GLP-1 use and employment and marriage, and our results for marriage contrast with some anecdotal reports in newspapers. Overall, our analysis adds new evidence about how GLP-1 use is affecting the lives of individuals with diabetes and suggest that the value of these drugs lies mostly in the primary outcomes of glycemic control and weight loss and not in broader domains of wellbeing measured here. Future research should continue to investigate these broader consequences, particularly as GLP-1 use becomes more common for weight loss and its use continues to expand beyond diabetics. Widespread adoption of GLP-1 use for weight loss will affect a large swath of the population and the consequences of such use beyond weight loss may be quite important.

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Table 1. Use of Long Acting GLP-1's Among Diabetics by Year

Years	Females			Males		
	GLP-1 in Year	Proportion of time on GLP-1 in the last two years up to the second-year outcome measurement	Proportion of time on GLP-1 between the two outcome measurements	GLP-1 in Year	Proportion of time on GLP-1 in the last two years up to the second-year outcome measurement	Proportion of Time on GLP-1 between the two outcome measurements
2012	0.01			0.01		
2013	0.03	0.01	0.01	0.02	0.01	0.01
2014	0.03	0.02	0.03	0.02	0.02	0.02
2015	0.04	0.02	0.03	0.03	0.02	0.02
2016	0.04	0.02	0.02	0.03	0.03	0.03
2017	0.07	0.03	0.03	0.05	0.01	0.02
2018	0.09	0.06	0.07	0.07	0.04	0.04
2019	0.11	0.06	0.07	0.08	0.05	0.06
2020	0.11	0.08	0.09	0.11	0.07	0.08
2021	0.14	0.09	0.10	0.15	0.11	0.12
2022	0.23	0.13	0.15	0.19	0.10	0.11
2023	0.31	0.19	0.21	0.23	0.16	0.18

Notes: Each person is observed in five rounds in a two-year panel and the outcomes are measured in round 2 in year 1 and round 4 in year 2. For each person, we calculated the proportion of the sample reporting use in a calendar year (e.g., 2012), and the proportion of time in the last two years up to the second-year outcome measurement (e.g., rounds 1-4) that the individual reported using long-acting GLP-1., and proportion of time between the two outcome measurements (e.g., round 3 and round 4) that the individual reported using long-acting GLP-1.

Table 2. Descriptive Statistics by Sample in Years Prior to Widespread Diffusion of GLP-1s

Variable	Females 2013-17	Males 2013-17
Age	51.6	52.0
Black	0.30	0.23
Hispanic	0.34	0.31
US Born	0.70	0.69
High School	0.31	0.32
Some College	0.24	0.22
BA or Higher	0.10	0.12
Diagnosed Heart Conditions	0.14	0.14
Diagnosed Cancer	0.11	0.07
Proportion of time on GLP-1 in the last two years up to the second-year outcome measurement	0.02	0.02
Proportion of Time on GLP-1 between the two outcome measurements	0.02	0.02
K6	5.3	3.7
K6>5	0.37	0.25
PHQ2 ≥3	0.20	0.13
Good Health	0.17	0.21
Poor Health	0.45	0.37
Employed	0.47	0.66
Married	0.47	0.64
Wid./Div./Sep.	0.33	0.19
Observations	1990	1712

Notes: Sample includes people ages 25 to 64 who were observed for at least two years from MEPS 2012 to 2023. Most individuals are observed for two years and contribute one observation (84.2% of the analysis sample). A smaller fraction was observed for three (9.2% of the sample) or four (6.7% of sample) years. Those observed for three years contribute two observations (year 1 and year 2, year 2 and year 3) and those observed for four years contribute three observations (year 1 and year 2, year 2 and year 3, year 3 and year 4).

Table 3
OLS Estimates of the Effect of Long Acting GLP-1's

	Females Mean of Dep. Var.	Cross-Sectional	Males Mean of Dep. Var.	Cross-Sectional
Kessler-6	5.3	-0.358 (0.473)	3.6	0.280 (0.478)
Kessler-6 >5	0.37	-0.047 (0.041)	0.25	0.039 (0.042)
PHQ2 ≥3	0.20	0.004 (0.033)	0.13	0.040 (0.033)
Excellent/Good Health	0.17	-0.051 (0.034)	0.21	-0.063 (0.041)
Fair/Poor Health	0.45	-0.000 (0.042)	0.37	0.063 (0.045)
Employed	0.47	0.046 (0.036)	0.66	0.007 (0.039)
Married	0.47	0.067 (0.038)	0.64	0.149** (0.041)
Div./Sep./Wid.	0.33	-0.060 (0.036)	0.19	-0.033 (0.036)

Notes: In the cross-section models, the dependent variable is the level of the outcome in the second year of a two-year panel for an individual. The key independent variable of interest is the proportion of time in the last two years prior to the second-year outcome measurement (e.g., rounds 1-4) that the individual reported using long-acting GLP-1. Additional controls include fixed effects for year, age, race, region, and education, indicator for born in the U.S., indicator for having health insurance, indicator for ever diagnosed with hypertension, indicator for ever diagnosed with high cholesterol, indicator for ever diagnosed with heart conditions, indicator for ever diagnosed with cancer, indicator for ever diagnosed with diabetes, linear and squared final personal weight, linear and squared self-administered questionnaire weight. * p-value <0.05, ** p-value <0.01

Table 4. Value-added and First-difference Models
OLS Estimates of the Effect of Long Acting GLP-1's

	Females			Males		
	Mean of Dep. Var.	First Difference	Value-Added	Mean of Dep. Var.	First Difference	Value-Added
Kessler-6	5.3	-0.113 (0.368)	-0.240 (0.333)	3.6	-0.486 (0.389)	-0.118 (0.351)
Kessler-6 >5	0.37	-0.003 (0.037)	-0.028 (0.032)	0.25	-0.050 (0.041)	-0.001 (0.035)
PHQ2 ≥3	0.20	0.007 (0.033)	-0.002 (0.028)	0.13	-0.005 (0.033)	0.022 (0.028)
Excellent/Good Health	0.17	-0.010 (0.033)	-0.036 (0.028)	0.21	0.041 (0.040)	-0.018 (0.035)
Fair/Poor Health	0.45	-0.024 (0.038)	-0.011 (0.033)	0.37	0.003 (0.042)	0.031 (0.037)
Employed	0.47	-0.008 (0.019)	0.001 (0.018)	0.66	-0.026 (0.020)	-0.026 (0.019)
Married	0.47	-0.007 (0.011)	-0.003 (0.011)	0.64	0.004 (0.012)	0.009 (0.012)
Div./Sep./Wid.	0.33	-0.003 (0.010)	-0.005 (0.010)	0.19	-0.008 (0.011)	-0.008 (0.011)

Notes: In the first-difference model, the dependent variable is the change in the outcome from round 2 in the first year to round 4 in the second year. The key independent variable of interest is the proportion of time on long-acting GLP-1 between the two outcome measurements (e.g., round 3 and round 4). Additional controls include fixed effects for year, age, race, region, and education, indicator for born in the U.S., indicator for having health insurance, indicator for ever diagnosed with hypertension, indicator for ever diagnosed with high cholesterol, indicator for ever diagnosed with heart conditions, indicator for ever diagnosed with cancer, indicator for ever diagnosed with diabetes, linear and squared final personal weight, linear and squared self-administered questionnaire weight. * p-value <0.05, ** p-value <0.01

Appendix Table 1. Sensitivity Analysis for the Value-added and First-difference Models

	Females			Males		
	Mean of Dep. Var.	First Difference	Value-Added	Mean of Dep. Var.	First Difference	Value-Added
Kessler-6	5.3	0.034 (0.414)	-0.129 (0.374)	3.6	-0.686 (0.429)	-0.291 (0.387)
Kessler-6 >5	0.37	0.008 (0.042)	-0.025 (0.036)	0.25	-0.047 (0.045)	0.001 (0.038)
PHQ2 ≥3	0.20	0.025 (0.038)	0.013 (0.032)	0.13	-0.000 (0.037)	0.028 (0.031)
Excellent/Good Health	0.17	-0.016 (0.037)	-0.045 (0.032)	0.21	0.044 (0.045)	-0.021 (0.039)
Fair/Poor Health	0.45	-0.006 (0.043)	0.008 (0.037)	0.37	0.007 (0.047)	0.035 (0.041)
Employed	0.47	-0.005 (0.022)	0.004 (0.021)	0.66	-0.025 (0.022)	-0.020 (0.021)
Married	0.47	-0.001 (0.012)	0.003 (0.012)	0.64	0.007 (0.013)	0.014 (0.013)
Div./Sep./Wid.	0.33	-0.006 (0.011)	-0.008 (0.011)	0.19	-0.011 (0.012)	-0.013 (0.012)

Notes: Sensitivity analysis for Table 4. The key independent variable of interest is the proportion of time on GLP-1 up to second-year outcome measurement. See other notes under Table 4. * p-value <0.05, ** p-value <0.01